IEC 61606-3

Edition 1.0 2008-10

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE

**Audio and audiovisual equipment – Digital audio parts – Basic measurement methods of audio characteristics –**
**Part 3: Professional use**



**Équipements audio et audiovisuels – Parties audionumériques – Méthodes fondamentales pour la mesure des caractéristiques audio –**
**Partie 3: Usage professionnel**

IEC 61606-3:2008

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## Équipements audio et audiovisuels – Parties audionumériques – Méthodes fondamentales pour la mesure des caractéristiques audio – Partie 3: Usage professionnel

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**Part 3: Professional use**

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International Standard IEC 61606-3 has been prepared by IEC technical committee 100: Audio, video and multimedia systems and equipment.

This bilingual version (2012-11) corresponds to the monolingual English version, published in 2008-10.

The text of this standard is based on the following documents:

| FDIS | Report on voting |
|---|---|
| 100/1428/FDIS | 100/1453/RVD |

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

The French version of this standard has not been voted upon.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of the IEC 61606 series, under the general title *Audio and audiovisual equipment – Digital audio parts – Basic measurement methods of audio characteristics*, can be found on the IEC website.

This International Standard is to be used in conjunction with IEC 61606-1.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

# AUDIO AND AUDIOVISUAL EQUIPMENT – DIGITAL AUDIO PARTS – BASIC MEASUREMENT METHODS OF AUDIO CHARACTERISTICS –

## Part 3: Professional use

## 1 Scope

This part of IEC 61606 is applicable to the basic measurement methods of audio equipment for professional use.

The definitions, measuring conditions and methods common to both consumer and professional equipment are described in the IEC 61606-1.

This standard contains details of definitions and measuring conditions and methods applicable to professional equipment which differ from those described in IEC 61606-1.

This standard excludes consideration of



- measurement of low-quality audio devices,
- measurement of low-bit-rate audio devices (‘sub-band’ or ‘perceptual’ coding devices),
- measurement of devices which significantly modify time or frequency characteristics of the signal, such as pitch shifters or reverberators,
- measurement of signals from analogue input to analogue output, beyond the most general,
- EMC and safety related testing.



## 2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60268-1, *Sound system equipment – Part 1: General*

IEC 60268-2, *Sound system equipment – Part 2: Explanation of general terms and calculation methods*

IEC 60958-1, *Digital audio interface – Part 1: General*

IEC 61260, *Electroacoustics – Octave-band and fractional-octave-band filters*

IEC 61606-1, *Audio and audiovisual equipment – Digital audio parts – Basic measurement methods of audio characteristics – Part 1: General*

AES11-2003, *AES Recommended Practice for Digital Audio Engineering – Synchronization of digital audio equipment in studio operations*

## 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

**3.1**
**aliasing components**
see definition in IEC 61606-1

**3.2**
**analogue full-scale input and output amplitude**
when applied to an analogue input of the EUT, it produces digital full-scale amplitude within the EUT; conversely, the analogue output full-scale amplitude is that which is produced at an analogue output from the EUT by a digital full-scale amplitude within the EUT

NOTE 1 Sometimes the range of an analogue input or output path may be less than that corresponding to digital full-scale amplitude. For this reason, analogue full-scale input and output amplitudes are usually inferred by driving the converters at a lower amplitude (see 6.3.1.1 and 6.3.2.1).

NOTE 2 The ideal values of these amplitudes cannot be defined within the standard since they are different for different EUTs, and may be modally variable for a single EUT.

NOTE 3 Where these values are unknown for an EUT at the outset of testing, they should generally be established first (using the methods described in 6.3.1.1 and 6.3.2.1 since it may subsequently be necessary, for example, to drive an analogue input at –60 $dB_{FS}$ or to measure an amplitude at an analogue output in $dB_{FS}$ relative to a digital stimulus.



**3.3**
**coding format**
a numerical convention used to represent digital audio data at the inputs or outputs of the EUT



NOTE This standard is primarily intended to be applied to EUTs which transact digital audio signals expressed as a stream of LPCM (Linear Pulse Code Modulation) samples; that is, a stream of binary words, directly representing the amplitudes of successive audio samples quantised at the sampling frequency, and rendered as binary 2's complement numbers. Positive analogue voltages correspond to positive digital sample values (that is, 2's complement numbers whose most-significant bit (MSB) is zero). Many of the methods described in the standard are applicable to other coding formats.

**3.4**
**decibels full-scale**
**$dB_{FS}$**
the r.m.s. amplitude of a sinusoid described in 3.10 is defined as 0 $dB_{FS}$, where the amplitude of any signal can be defined in $dB_{FS}$ as 20 times the common logarithm of the ratio of the r.m.s. amplitude of the signal to that of the signal defined in 3.10

NOTE Analogue amplitudes at the input or output of an EUT can be expressed in $dB_{FS}$ by referring to the analogue full-scale input or output amplitudes as defined in 3.2.

**3.5**
**digital audio interface**
a physical medium upon which digital audio data are transferred into or out of the EUT

NOTE Digital audio interfaces may include packaged media (such as in the case of a CD player) or radio-frequency (RF) carriers (such as in the case of a set-top-box) as well as conventional copper or optical digital interconnections.

**3.6**
**digital audio signal**
see definition in IEC 61606-1

**3.7**
**digital zero**
see definition in IEC 61606-1

**3.8**
**equipment under test**
**EUT**
see definition in IEC 61606-1

NOTE In structuring an equipment or installation specification, it is important to consider the way in which the different elements of the equipment might best be segmented for the purposes of the specification or measurement. A basic D/A converter, for example, would represent a simple EUT with 'General characteristics', 'Digital input characteristics' and 'Analogue output characteristics'. But consider a large studio mixing console, which may have many different functional blocks, and many different inputs and outputs of different types and in different domains. Such a mixing console example might be considered as a collection of different elements; for example, 'analogue line inputs', 'analogue mic inputs', 'AES3 inputs', 'channel equalizers', 'mix bus processors' etc. Typically, different measurement criteria are applicable to each different element, and different performance levels might be specified. In such a case each element or subsystem should, where possible, be considered as a discrete 'EUT' and should be specified and measured individually. In addition, typical signal paths through the entire equipment may also be specified, and their performance criteria stated as a single EUT.

**3.9**
**folding frequency**
half the sampling frequency of the EUT

NOTE 1 Signals above this frequency applied to the EUT are subject to aliasing.

NOTE 2 Complex EUTs may have an input folding frequency and an output folding frequency which are different. In such cases, where input or output is unspecified, the folding frequency shall refer to the lower frequency.

**3.10**
**full-scale amplitude**
**FS**
amplitude of a 997 Hz sinusoid whose peak positive sample just reaches positive digital full-scale (in 2's-complement a binary value of 0111…1111 to make up the word length) and whose peak negative sample just reaches a value one away from negative digital full-scale (1000…0001 to make up the word length) leaving the maximum negative code (1000…0000) unused



**3.11**
**high and low interference frequencies**
moderately high and low signal frequencies of 15 kHz and 60 Hz respectively at which certain interference effects may be quoted if a graphical report is not required

**3.12**
**in-band amplitude**
an amplitude measurement incorporating a standard low-pass filter so as to exclude out-of-band components above the upper band-edge frequency

**3.13**
**in-band frequency range**
see definition in IEC 61606-1

**3.14**
**input word length**
the maximum audio word length which can be applied to a digital input of the EUT at its present settings, for which the least significant bit is not ignored

**3.15**
**interface jitter**
timing errors in the transitions of a digital audio carrier or reference sync, owing to cabling effects or jitter in the clock of the sourcing equipment

**3.16**
**jitter susceptibility**
the effect on EUT performance as a result of sampling jitter caused by interface jitter on the incoming reference sync

**3.17**
**maximal measuring amplitude**
a signal amplitude of –1 $dB_{FS}$, close to (but below) full scale amplitude, which is applied to the EUT in certain of the described methods

NOTE This definition can apply to either a digital or an analogue signal (see 3.4).

**3.18**
**normal load impedance**
required differential input impedance of the analogue measuring equipment defined as 100 kΩ or more, in parallel with not more than 500 pF in this standard

**3.19**
**normal measuring amplitude**
a signal amplitude of −20 $dB_{FS}$, representative of a typical operating amplitude, which is applied to the EUT in certain of the described methods

NOTE This definition can apply to either a digital or an analogue signal (see 3.4).

**3.20**
**normal measuring frequency**
a signal frequency of 997 Hz, representative of a typical mid-range frequency, which is applied to the EUT in certain of the described methods



**3.21**
**normal source impedance**
required differential output impedance of the analogue measuring equipment defined as 50 Ω or less for a balanced output and 25 Ω or less for an unbalanced output in this standard

**3.22**
**out-of-band amplitude**
amplitude measurement incorporating a standard out-of-band filter so as to exclude in-band components below the upper band-edge frequency

**3.23**
**out-of-band frequency range**
frequency range from the folding frequency to 192 kHz (or some other stated maximum)

NOTE Signals applied to the EUT input in this frequency range are subject to aliasing.

**3.24**
**output word length**
number of significant bits transmitted by a digital output of the EUT at its present settings, of which none is continuously zero

**3.25**
**residual amplitude**
an amplitude measurement incorporating a standard band-reject filter to suppress the effects of an unwanted frequency, usually the stimulus frequency

**3.26**
**sampling frequency**
$f_s$
the rate at which audio samples are processed within the EUT

NOTE Complex EUTs may have an input sampling frequency and an output sampling frequency which are different. In such cases, where input or output is unspecified, the sampling frequency shall refer to the lower frequency.

**3.27**
**sampling jitter**
timing errors in the sampling instants applied by an A/D converter, D/A converter or asynchronous sample-rate converter which lead to phase modulation of the converted audio signal

**3.28**
**selective amplitude**
amplitude measurement incorporating a standard band-pass filter to suppress the effects of spurious components and wideband noise

**3.29**
**standard third-octave frequencies**
set of measurement frequencies set at one-third-octave intervals, as defined in IEC 61260, where these frequencies are preferred whenever third-octave analysis is specified

**3.30**
**upper band-edge frequency**
see definition in IEC 61606-1

# 4 Rated values



For a full explanation of these terms, see IEC 60268-2. The followings are rated conditions for digital audio equipment. They should be specified by the manufacturer.



- rated supply voltage
- rated supply frequency
- rated pre-emphasis and de-emphasis characteristics
- rated digital input word length
- rated sampling frequencies

# 5 Measuring conditions

## 5.1 Environmental conditions

Where environmental conditions for EUT operation are specified by the manufacturer, measurements will be assumed to be valid over the entire range, and shall be so verified. In the absence of an environmental specification, tests will be performed at a temperature of 25 ˚C ± 10 ˚C, relative humidity of 60 % ± 15 % and air pressure of 96 kPa ± 10 kPa.

## 5.2 Power supply

Power-line (mains) voltage shall be set within 2 % of the nominal value listed on the panel of the device being tested. If a range of values is given, the specifications are assumed to be valid over the entire range and may be so verified.

Power-line (mains) frequency shall be set within 1 % of the nominal value listed on the panel of the device being tested. If a range of values is given, the specifications are assumed to be valid over the entire range and shall be so verified.

For dc-powered devices the dc supply voltage shall have a peak-to-peak ripple content of less than 0,5 % of the nominal supply voltage.

### 5.3 Test signal frequencies

The test signal frequencies defined in IEC 61606-1 are not especially applicable in the professional context. Although these frequencies are referenced where possible, in general this standard specifies directly such frequencies as may be required.

### 5.4 Standard settings

All controls of the EUT shall be set to the reference positions specified by the manufacturer, or to their normal operating positions or to those specified in IEC 61606-1 where none is specified.

### 5.5 Preconditioning

The EUT shall be preconditioned as described in IEC 61606-1.

### 5.6 Measuring instruments

#### 5.6.1 General

All measuring instruments specified in this standard shall comply with the instrument specifications in 4.6 of IEC 61606-1 except for variations and additions to their specifications as detailed in this document.

In general, equivalent analogue and digital instruments should behave identically except where detailed.



Digital instruments shall be able to generate and analyze data in whatever digital audio interface format(s) are supported by the EUT.



Analogue instrument outputs should present the normal source impedance as defined in 3.21; analogue instrument inputs should present the normal load impedance as defined in 3.18.

#### 5.6.2 Signal generator

##### 5.6.2.1 Generator modes

The methods described in this Clause require a variety of generator modes, which are detailed below. These are most easily realised using a multi-function generator.

The different generator modes are indicated for each method by a generator block symbol as shown in Figure 1.

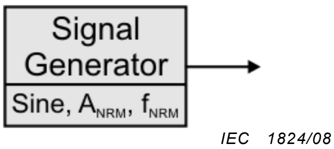


**Figure 1 – Signal generator**

The lower section of the symbol describes the mode of the generator: its function, amplitude and frequency settings. Abbreviations are as follows:

Amplitude:

- NRM Normal measuring amplitude
- MAX Maximal measuring amplitude

- SWP Swept amplitude; the method is repeated at each of a defined series of test amplitudes
- ADJ Manually adjusted amplitude

Frequency:

- NRM Normal measuring frequency
- UBE Upper band-edge frequency
- SWP Swept frequency

Other settings, as required in various modes, are described in the accompanying text.

If synchronous multi-tone analysis is to be performed, the signal generator shall additionally have wavetable generation capabilities as described in A.1.

#### 5.6.2.2 Dither

Unless otherwise stated, all stimuli which are used to drive the EUT in the digital domain shall be dithered with triangular probability-density function (TPDF) white dither at the appropriate amplitude as determined by the input word length of the EUT.

NOTE This type of dithering precisely linearizes the quantization noise of the test stimuli to finite word lengths. It is achieved by adding a dither signal to the test stimulus signal prior to its truncation to the input word length of the EUT. The correct dither signal is a random or pseudo-random sequence having a triangular probability density function (TPDF), no DC offset, and a peak-to-peak amplitude of two least-significant bits of the EUT input word length. The amplitude is constant per unit bandwidth (white) up to at least the upper band-edge frequency. TPDF is achieved by adding pairs of uniformly-distributed random or pseudo-random numbers to form each dither sample; the generating sequence should be long in duration and maximally random, and the extraction points of the number pairs should be well separated in order to minimize correlation.



#### 5.6.2.3 Accuracy

Signal generators used for measurements in this standard shall provide control over frequency with an accuracy of at least ±0,05 %. For analogue signal generators, the frequency may be measured with a frequency counter and adjusted to be within the required accuracy. The frequency adjustment resolution shall be adequate to produce the frequencies specified for each test.

Analogue stimuli shall be generated with an amplitude accuracy of at least ± (0,2 dB + 3 μV) at the normal measuring frequency, and ±(0,3 dB + 3 μV) from 20 Hz to the upper band-edge frequency. Digital stimuli shall be generated with an amplitude accuracy of ±(0,01 dB + 0,5 LSB).

### 5.6.3 Signal analyzer

#### 5.6.3.1 Analyzer modes

The methods described in this Clause require a variety of analyzer modes which are detailed below. These are most easily realised using a multi-function analyzer. However, individual filters, meters etc. may be used if required. All amplitude measurements specified in this standard shall be made with true root-mean-square (r.m.s.) responding meters. Filters are described in 5.6.3.2.

A wideband amplitude meter, as shown in Figure 2, is a simple r.m.s. amplitude meter with no pre-metering filters.

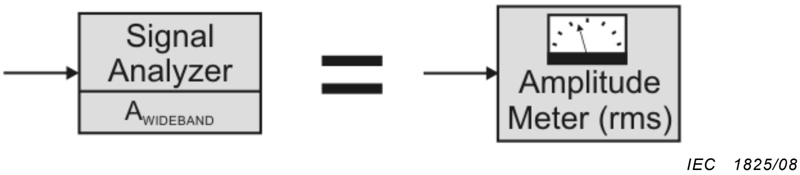


**Figure 2 – Wideband amplitude**

An in-band amplitude meter, as shown in Figure 3, incorporates the low-pass filter as described in 5.6.3.2.1.

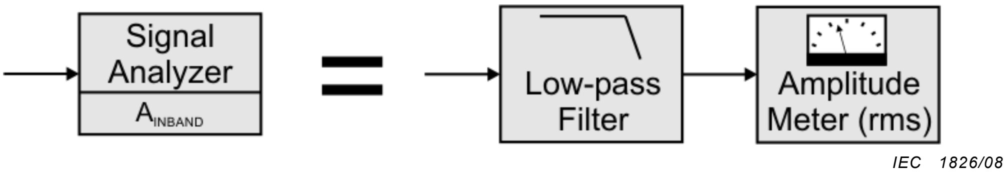


**Figure 3 – In-band amplitude**

An out-of-band amplitude meter, as shown in Figure 4, incorporates the high-pass filter as described in 5.6.3.2.2.

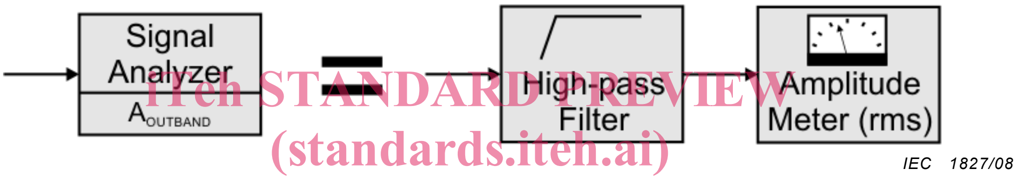




**Figure 4 – Out-of-band amplitude**



A selective amplitude meter, as shown in Figure 5, incorporates the band-pass filter as described in 5.6.3.2.3 to measure the amplitude of a single frequency component. Unless otherwise stated, the band-pass filter is auto-tuned to the generator frequency.

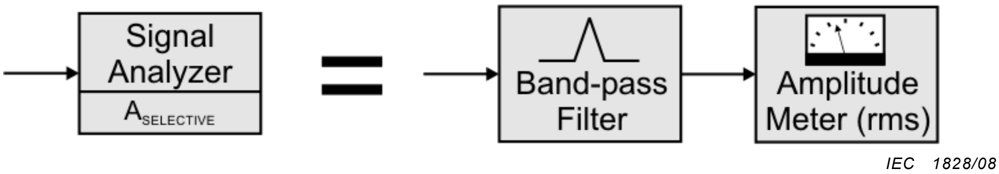


**Figure 5 – Selective amplitude**

A residual amplitude meter, as shown in Figure 6, incorporates the band-reject filter as described in 5.6.3.2.6 to exclude the effects of a single frequency component, usually the stimulus frequency. Unless otherwise stated, the band-reject filter is auto-tuned to the predominant input frequency.

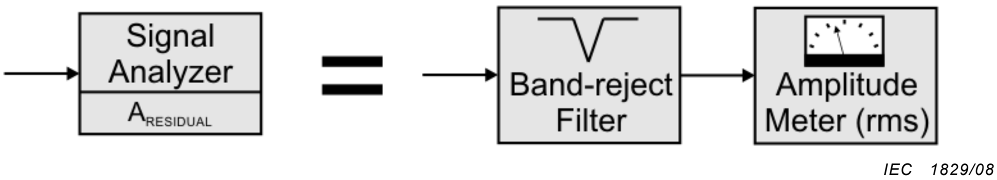


**Figure 6 – Residual amplitude**

A weighted amplitude meter, as shown in Figure 7, incorporates the weighting filter as described in 5.6.3.2.9.